IFAU – INSTITUTE FOR
LABOUR MARKET POLICY
EVALUATION

Teacher supply and the market for teachers

Christian Andersson
Nina Waldenström

WORKING PAPER 2007:5

The Institute for Labour Market Policy Evaluation (IFAU) is a research institute under the Swedish Ministry of Employment, situated in Uppsala. IFAU's objective is to promote, support and carry out: evaluations of the effects of labour market policies, studies of the functioning of the labour market and evaluations of the labour market effects of measures within the educational system. Besides research, IFAU also works on: spreading knowledge about the activities of the institute through publications, seminars, courses, workshops and conferences; influencing the collection of data and making data easily available to researchers all over the country.

IFAU also provides funding for research projects within its areas of interest. The deadline for applications is October 1 each year. Since the researchers at IFAU are mainly economists, researchers from other disciplines are encouraged to apply for funding.

IFAU is run by a Director-General. The authority has a board, consisting of a chairman, the Director-General and seven other members. The tasks of the board are, among other things, to make decisions about external grants and give its views on the activities at IFAU. A reference group including representatives for employers and employees as well as the ministries and authorities concerned is also connected to the institute.

Postal address: P.O. Box 513, 751 20 Uppsala
Visiting address: Kyrkogårdsgatan 6, Uppsala
Phone: +46 18 471 70 70
Fax: +46 18 471 70 71
ifau@ifau.uu.se
www.ifau.se

Papers published in the Working Paper Series should, according to the IFAU policy, have been discussed at seminars held at IFAU and at least one other academic forum, and have been read by one external and one internal referee. They need not, however, have undergone the standard scrutiny for publication in a scientific journal. The purpose of the Working Paper Series is to provide a factual basis for public policy and the public policy discussion.

ISSN 1651-1166

Teacher supply and the market for teachers*

Christian Andersson♣ and Nina Waldenström♦

February 20, 2007

Abstract

The share of non-certified teachers in Swedish compulsory public schools has grown considerably during the last decade, from 7.2 percent in 1995/96 to 17.2 percent in 2003/04. Moreover, comparisons between schools and municipalities indicate large and increasing differences in the share of non-certified teachers over time. In this paper we study whether these patterns may be explained by restrictions in the supply of certified teachers. We do this by using a temporary targeted governmental grant, aimed at increasing the personnel density in schools, as an exogenous teacher demand shock. Our results show that the introduction of the grant decreased the share of non-certified teachers more in areas characterized by relatively high unemployment rates among certified teachers, i.e., where teacher supply restrictions were relatively low. These findings hence suggest that teacher supply restrictions do indeed matter for the composition of teaching staff.

Keywords: Teacher supply, teacher certification, government grant
JEL-code: I21

* The authors are grateful for helpful comments from Bernardino Cesi, Peter Fredriksson, Rickard Friberg, Erik Grönqvist, Per Johansson, Mikael Lindahl, Erik Mellander, Jonas Vlachos, Daniel Waldenström, Björn Öckert, and seminar participants at the Department of Economics at Uppsala University and Stockholm School of Economics. Financial support from Swedish Research Council for Working Life and Social Research (FAS 2004-1220), The Swedish National Agency for Education and Wallander-Hedelius Foundation are gratefully acknowledged.

♣ Department of Economics, Uppsala University, Box 513, SE-751 20 Uppsala, Sweden. E-mail: Christian.Andersson@nek.uu.se.

♦ Department of Economics, Stockholm School of Economics, Box 6501, SE-113 83 Stockholm, Sweden. E-mail: Nina.Waldenstrom@hhs.se.

Table of contents

1 Introduction 3

2 Data and definitions 5
2.1 Data set 5
2.2 The special government grant – the Wärnersson grant 7

3 The market for teachers 10
3.1 Theory 10
3.2 The Swedish market for teachers 17
3.2.1 The structure of the market 17
3.2.2 Descriptive statistics 20
3.3 Previous literature on teacher certification 25

4 Model 27
4.1 Motivation and hypotheses 27
4.2 Econometric framework 29

5 Results 32

6 Conclusions 36

References 38

Appendix 42

1 Introduction

The role and importance of school resources and educational inputs on student achievement are often discussed by politicians and researchers. Since education reflects the production of human capital it constitutes a very important sector in every economy. Teachers constitute the largest part of the school budget and are considered to be the most important input in the production of education. Policies aimed at increasing the quantity and quality of teachers have therefore been at the forefront of recent educational reforms in Sweden.[1]

It is common in the ongoing school debate to equalize certification and experience with quality and the general perception is that these characteristics are very important for teacher quality. Therefore, an increased percentage of non-certified teachers as well as fewer teachers per student and increasing class sizes are often regarded as alarming. In Sweden, for example, the median share of non-certified teachers in public compulsory schools has grown considerably during the last decade, from 7.2 percent during the academic year 1995/96 to 17.2 percent in 2003/04, with a peak of 18.6 percent in 2002/03.

The explanations to this trend may be found in both the demand for and supply of different types of teachers. Increased wage differences between certified and non-certified teachers, usually in combination with a tight budget constraint, and a deterioration in the quality of the teacher education, are examples of factors that may decrease the demand for certified teachers. Further, the supply of certified teachers is a function of the attractiveness of the teaching profession which in turn depends on factors such as relative salaries, alternative opportunities, merit-based incentives, working conditions, status, and education as well as certification costs. A decrease in the supply of certified teachers, ceteris paribus, may be an explanation to the increase of non-certified teachers in schools. Existing studies have examined how different factors affect the demand for and supply of teachers, but as far as we know there are no studies examining the prevalence of non-certified teachers and changes in this group's magnitude. The present paper aims to fill part of this gap.

The local authorities' budget situation may directly affect the teacher employment decisions. Poor municipalities with stretched budgets may choose

[1] About 50 percent of the expenditures for Swedish compulsory schooling in 2004 were teaching expenditures, i.e., mostly expenditures for teacher and supervisor wages.
Source: http://www.skolverket.se/content/1/c4/35/59/TAB111NY.xls

to employ non-certified teachers, given that they cost less. However, the Swedish school law states that only certified teachers should be employed, except when such teachers are not available. The school budget or the general economic situation are therefore not likely to be the entire explanation to the observed development, and we claim that another potential explanation could be restrictions in the supply of certified teachers.

We control for the municipalities' economic situation and focus on the supply of certified teachers. Specifically, we investigate how changes in the supply of certified teachers in different local labor markets (LLMs), measured as the unemployment rate among certified teachers in these LLMs, affect the share of non-certified teachers in schools.

The econometric framework is the following. We use both a fixed effects model in which school-specific effects are accounted for and a difference-in-difference estimator using a temporary targeted government grant, the Wärnersson grant (*WG*), named after the former Swedish Minister for Schools, Ingegerd Wärnersson. This grant was instituted with the purpose to increase the personnel density in Swedish schools. The distribution of the grant among municipalities rested on demographical aspects and could not be influenced by individual schools or municipalities, at least not in the short run. The introduction of the grant implied a demand shock for teachers and we hypothesize that it increased the share of non-certified teachers more in areas characterized by low unemployment among certified teachers (implying severe constraints on teacher supply) than in areas with high unemployment rates among certified teachers. For any given level of the grant, we are hence able to isolate the marginal effect of teacher supply restrictions on the share of non-certified teachers.

Our findings provide an overall support for our hypothesis that supply restrictions are significant in explaining the teacher composition in public compulsory Swedish schools and that the effects are relatively large. In the remainder of the paper, when not specified, "teachers" will refer to certified teachers, i.e., teachers possessing a teaching certification, "teacher supply" will refer to the supply of certified teachers and "unemployment rate" will refer to the unemployment rate among these. Similarly "schools" will always refer to "Swedish compulsory schools" and "the grant" refers to the *WG*.

The paper is structured as follows. In section 2 we present the data and variable specifications as well as a description of the Wärnersson grant. Section 3 describes the market for teachers and briefly summarizes parts of the

previous relevant literature. In section 4 we introduce and discuss the model, hypothesis and the econometric framework. The results are presented in section 5 and the paper is concluded in section 6.

2 Data and definitions

2.1 Data set

The study extends over the time period 1995/96–2003/04 and covers all public compulsory schools. The original data come from the Teacher register, the IFAU database and the HÄNDEL database. We also use data from Statistics Sweden and the National Board for Education.

The Teacher register (*Lärarregistret*) is administrated by Statistics Sweden and contains information about all teachers active in public as well as independent schools in Sweden. The Teacher register provides information about the teacher's age, gender, range of duty, school and municipality code, whether the school is independent or public, and whether the teacher is certified or not. Beginning in the academic year of 1999/2000 the register also contains information about the number of (active) years in teaching. Regarding certification, teachers are divided into three categories: teachers teaching within their area of certification (*certified* teachers), teachers teaching outside their area of certification (*out-of-field* teachers) and teachers without any teaching certification (*non-certified* teachers or *out-of-license* teachers). Whether to treat *out-of-field* teachers as certified or not in our analysis is not entirely clear but since they hold a formal teacher education we choose to treat them as certified meaning that employed certified teachers in our analysis refers to both *certified* and *out-of-field* teachers. Treating *out-of-field* teachers as non-certified would also be reasonable, but as can be seen in the econometric analysis the choice of definition does not change our qualitative results.

Statistics Sweden has matched the Teacher register with information from the IFAU database, which covers the time period 1985–2003 and contains detailed information about the entire Swedish population aged 16 to 65.[2] We extract information about annual earnings, educational attainment and field of education.

[2] This database was created during 2000–2001 by The Institute for Labour Market Policy Evaluation (IFAU) in co-operation with Statistics Sweden. The individuals can be traced longitudinally through the educational system and on the labor market.

The HÄNDEL database, which is maintained by the National Labor Market Board (*Arbetsmarknadsstyrelsen*), contains all unemployment spells registered at the Public Employment Service (PES) offices. Using these data we calculate the unemployment rate among certified teachers.[3] Since the HÄNDEL database also report the type of job unemployed individuals are searching for we are able to restrict the unemployment measure among certified teachers to unemployed certified teachers reporting that they are searching for a teaching job.[4] The unemployment rate among certified teachers is defined at the local labor market (LLM) level although data is available at the municipality level. The motivation is that teachers are mobile between adjacent municipalities and within the LLM consisting of these municipalities. It is therefore reasonable to assume that it is not only the supply of teachers within a certain municipality that matters for the employment decision but rather the supply in the entire LLM.[5] Similarly, we measure the overall unemployment rate at the LLM level. The unemployment rate among certified teachers in a LLM a specific year is calculated as the total number of unemployed certified teachers divided by the total number of employed certified teachers plus the total number of unemployed teachers. The total number of employed teachers in a LLM a specific year is calculated using data from the Teacher register.[6] The number of employed teachers in the Teacher register is measured during one week in October each year. The number of unemployed teachers is therefore measured during the same week.

The share of non-certified teachers at the school level is defined as the number of non-certified full time equivalent teachers employed in a specific school a certain academic year divided by the total number of employed full time equivalent certified and non-certified teachers in the same year and school. This share is then multiplied by one hundred to get the percentage non-certified teachers.

Into our final dataset we also incorporate the overall unemployment rate at the LLM level and the income equalization grant at the municipality level.[7]

[3] As unemployed individuals have to register at a PES office to be eligible for unemployment benefits, the registrations at the PES provide reliable information about unemployment.

[4] Due to the matching with the IFAU database we can infer whether unemployed individuals are certified teachers or not. In the unemployment context, certification means that an unemployed individual holds a teaching degree.

[5] Sweden consists of 290 municipalities that are divided into 85 local labor markets.

[6] Measured as physical individuals (employed).

[7] The income equalization grant is a revenue sharing grant with the purpose of guaranteeing all municipalities a tax base equivalent to the country's average. Municipalities with a tax base

The overall unemployment data is collected from Statistics Sweden and the income equalization grant data has been received from IFAU.

Using information on all teachers in compulsory schools over the time period 1995/06 - 2003/04 the original data set contains 1 285,037 observations. However, we exclude all independent (private) schools which reduce the sample size by 59,945 observations. This restriction is applied since independent schools were not allowed to directly apply for the *WG*. Municipalities had the possibility to allocate part of the grant to independent schools but in general this share has been very low or zero.[8] Further, since our analysis is conducted at the school level we aggregate the data to this level, resulting in a total of 41,246 observations. From this sample of schools we delete special schools like hospital schools and schools for refugees only. We also exclude schools with extreme teacher density since these are likely to be misreported.[9] This reduces our sample with 6,005 observations. The final dataset used in our econometric analysis contains a total of 35,241 observations, i.e., around 3,900 schools per year are observed.

Inspecting our data we note that non-certified teachers are on average younger, have less experience and are less educated than their certified colleagues. About 98 percent of all certified teachers have more than two years of university studies while the corresponding number for non-certified teachers is only about 48 percent. The teacher occupation is also very dominated by females. Above 70 percent of all teachers in compulsory schools are females. Further descriptive statistics of the variables used in our analysis are provided in Table A1 in Appendix.

2.2 The special government grant – the Wärnersson grant

The Swedish school system has since the late 1980s experienced a number of economic and institutional changes that have profoundly affected its way of working. For example, responsibility for teacher employment shifted from central to local authorities in 1991 and there was a rapid increase in the number of students. (Ahlin & Mörk (2007))

---

lower than the average receive a grant and those with higher pay a fee (Svenska Kommunförbundet (2003)).

[8] A broader description of the Wärnersson grant and the prevailing application rules are provided in the next section.

[9] The teacher density distribution among schools are trimmed for the two highest and two lowest percentiles. This has no effect on our overall results.

To counteract this development the Swedish government instituted a targeted government grant, the Wärnersson grant (*WG*), to be distributed to municipalities from the academic year 2001/02 until 2006/07. The aim of the grant was to increase the personnel density in preschools, nine-year compulsory schools, special schools, after-school recreation centers and upper secondary schools, in order to give children and youths increased chances of reaching their educational goals.[10] In terms of number of employees, this represents a school personnel increase by about 15,000 positions. In year 2000 there were almost 77,000 full time equivalent teachers employed in public compulsory schools. In total SEK 17.5 billions (approximately € 1.8 billion) were set aside to be distributed to municipalities.[11] Only municipalities could apply for and receive the *WG*, but they are allowed to freely distribute it among public and independent schools. The government commissioned the Swedish National Agency for Education to administer, follow up, and evaluate the *WG*.

All municipalities (except for two) applied for and received the grant in the first year. All municipalities applied for and received the grant in 2002/03 and all except two applied for and received the grant in 2003/04.[12] The grant corresponded to around two percent of the educational sector's expenditures and all municipalities did show an interest in the grant. The fundamental demand on municipalities to receive the grant was to increase the personnel density compared to the year before the first grant year. The reason why a few municipalities did not apply for or did not receive the grant a certain year has been that these municipalities realized beforehand that they would not be able to meet the demand of increased school personnel density.[13]

A grant frame is calculated for each municipality yearly. This frame is based on the number of inhabitants between 6 and 18 years-of-age that lived in the municipality the calendar year preceding the grant year, i.e., the grant frame for 2001/02 is based on the number of children and youths aged 6–18 during

[10] SFS 2001:36.

[11] In 2005, the government changed some of the original conditions of the grant. However, coming into force after the end of our period of study and because these changes could not be anticipated during the period of study, they do not affect our analysis. We therefore focus on the grant conditions and rules prevailing during the years included in the analysis, i.e., during 2001/02 - 2003/04. Part of the grant was in 2005 transferred to the general government grant framework. In 2007 the grant was fully included in the general grant. Further information about how the conditions changed in 2005 is available at http://www.skolverket.se.

[12] The two municipalities that did not receive the grant in 2001/02 were Österåker and Umeå. Nacka and Sundbyberg did not apply in 2003/04.

[13] Riksrevisionen, RiR 2005:9, p. 33.

2000. The basic principle underlying the decision whether new grants are approved or not is that the municipality has to increase the school personnel density compared to an index year. The index year for 2001/02 - 2003/04 was 2000/01. If a grant receiving municipality does not comply with the requirements associated with the grant, the National Agency for Education might decide to stop further payments or even to reclaim already disbursed payments.

Fortunately – for evaluation purposes, the consequences of exceeding the school budget or of having a high/low school personnel density during 2000/01 were not known by the municipalities until after the end of this index year. The government bill that introduced the *WG* and the decree that the government issued later both mentioned that the grant was aimed at increasing the school personnel density but they did not specify how this density should be measured. It was first in the instructions issued by the National Agency for Education in 2001 that the "index year comparison" was described.[14]

The aim of the grant is thus to increase school personnel. Municipalities with constant pupil populations have to increase the school personnel by employing new staff while municipalities with receding pupil populations could use the grant in order to keep the personnel who otherwise might have been discharged because of the decline in the number of students. In case of increasing pupil populations the municipalities have to invest own resources in order to keep the teacher density at the same level as it was during the index year.

Because of poor economic conditions, some municipalities have come to different agreements with the Swedish government and were allowed to use the *WG* to prevent a decline in the school personnel density.[15]

The information about the *WG* was collected by the Swedish National Agency for Education and we use data for the first three grant years. These are the three last years in our studied time period. The grant amount is defined in real thousands of SEK per student and year.[16] In the first grant year, 2001/02, about 1 billion SEK was distributed to the Swedish municipalities. In the academic year of 2002/03 the grant amounted to almost 2 billion SEK and in 2003/04 almost 3 billion SEK. In real terms the mean grant equaled 628 SEK

[14] Riksrevisionen, RiR 2005:9, p. 34.
[15] In total 57 municipalities. These municipalities are included in the analysis, but excluding them does not change our qualitative results.
[16] Consumer price index is used as deflator.

per student in 2001/02, 1,258 SEK per student in 2002/03 and 1,897 SEK per student in 2003/04.[17]

3 The market for teachers

Wages, employment agreements and work place conditions are some examples of factors that affect the status and attractiveness of the teaching profession and therefore the supply of qualified teachers, as well as the distribution of qualified teachers over schools and school districts. In Sweden as well as in several other countries, the teaching profession has lost in status. We also observe a decrease in the test scores of students applying for the teaching education, see for example Björklund, Clark, Edin, Fredriksson & Krueger (2005), and an increase in the share of non-certified teachers in schools. Moreover, there are large differences in the composition of teacher staff with respect to certification between schools and municipalities.

In this section we present a simple general supply and demand analysis, we describe the Swedish market for teachers and summarize relevant literature.

3.1 Theory[18]

The market for teachers differs slightly from other labor markets mainly because of aspects that make it less competitive than other labor markets. Such factors are for example the government's dominant position as a provider and regulator of the education sector, the heterogeneity of the teaching services, the prevailing labor market institutions, and the mode of procedure when recruiting, selecting and employing teachers. The uncompetitive character of the labor market for teachers affects the demand and supply of teachers and thus the equilibrium outcome.

Teacher demand

There are several factors determining the demand for teachers and the government can influence most of them. The number of teachers needed in a school system depends on the number of students, class size, required learning hours for students and the teaching load of teachers. The required teacher qualifications in general and the relative demand for teachers in different

[17] € 1 is approximately equal to SEK 9.4.

[18] This section is mainly based on Santiago (2004). Here we give only a brief picture of the functioning of the teacher market. For a more detailed description see Santiago (2004).

subjects, in particular, depend mainly on the school curriculum. The curriculum's balance between different subjects as well as the students' preferences over the optional courses within the flexible part of the curriculum influences the demand for different teacher skills.

At an aggregate level, i.e., ignoring the stratified nature of the market[19], the demand for teachers is increasing in the student population and the number of required learning hours for students and decreasing in class size and the teaching load for teachers.

The number of teachers that can be employed is also restricted by the budget for teacher expenditures in combination with teacher wage levels. By adjusting the budget for teacher expenditures a government can influence the number of teachers that are employed. What a government can not influence, at least not in the short run, is the demographic aspect, namely the size of the school-age population.

This description of the teacher demand is simplistic in that it does not account for the stratified character of the market, nor for the fact that the decisions often are taken at the local level. A more realistic approach would be to specify the demand by, e.g., subject matter, educational program and grade level. However, in this paper we address the market for teachers at an aggregate level and a detailed description of the teacher demand is thus beyond the scope of this study.

Teacher supply

The supply of eligible teachers is defined by the number of persons possessing the required qualifications that are willing to provide teaching services given prevailing conditions and incentives such as salaries, working conditions and availability of teaching positions. This number is a function of the attractiveness of the teaching profession which depends on factors such as relative salaries and alternative opportunities, merit-based incentives, working conditions, professionalism, status, and education as well as certification costs.

The pool of certified teachers for a given year consists of two main sources; active teachers from the previous year who choose to remain in the profession and new entrants into the profession. The former may be either employed or unemployed searching for teacher appointments. New entrants consist of newly

[19] There are demand differences at the level of education, type of program, subject matter, geographical location and type of provider (public or independent).

graduated teachers from teacher preparation programs and certified teachers working in other sectors that are attracted back into teaching careers.

The role of relative salaries and alternative opportunities for the decision to enter and stay within the teaching profession are often discussed by policy makers and researchers. It is usually argued that high relative wages attract and retain talented teachers and induce current teachers to maximize their effort. Moreover, high salaries have been argued to be a good compensation for poor working conditions in certain schools and regions and thus a tool to prevent teachers from switching locations.[20] The effects of the existence of alternative opportunities to teaching have also been analyzed, especially in the context of changes in women's labor supply as a consequence of increased employment opportunities. It has been argued that the quality of women applying for teacher certification has decreased since top students are attracted to other sectors.[21]

Another factor influencing the attractiveness of the teaching profession and thus the supply of teachers is the prevailing working conditions. Class size, working load, composition of the student body and faculty, safety, opportunities for participating in professional development activities and flexibility regarding temporary leave are some of the working condition components that affect the decision of entering and staying in the profession. The status of the teaching profession also matters for the teacher supply. The teachers' degree of influence on decisions regarding major aspects of school operations, career ladders and in-service training are factors that increase the status of the teaching profession.

The supply of eligible teachers also depends on the cost of becoming a teacher; the requirements to obtain a teacher certification along with the structure of the teacher education can make the entry in the profession more or less difficult and therefore costly. Lower requirements may attract more but less dedicated people while harder requirements may scare away some potential applicants.

[20] The existing literature provides mixed evidence on these issues. Some studies suggest that the relative wages do indeed affect the decision of entering the profession as well as the decision to stay in teaching. Other studies indicate that teacher salaries do not influence the decision to enter teacher educational programs or the decision to switch location or profession. Factors as student characteristics are instead emphasized as more important for teachers' transition decisions. For literature references see for example Santiago (2004).

[21] See for example; Corcoran, Evans & Schwab (2004), Bacolod (2002), Stoddard (2003) and Temin (2002).

In our study we use the unemployment rate among certified teachers as an approximation for the supply of certified teachers in Sweden. Given a teaching vacancy, the pool of certified applicants can be argued to consist of already employed certified teachers, unemployed certified teachers, and certified teachers working outside the teaching profession. However, the interest in and the status of the teaching profession seems to have declined in Sweden (Björklund et al (2005)). Therefore it should not be controversial to assume that most of the certified teachers working outside the teaching profession do not re-enter it. Certified teachers working outside the teaching profession should thus represent a small share of the pool, which motivates that our supply measure abstracts from them. Regarding candidates already teaching in other schools we argue that these will not affect the size of the applicant pool either, at least not at our level of aggregation, since they leave a vacancy behind them which must be filled, given an increasing total number of teaching positions.[22] Therefore we claim that an adequate measure of the supply of certified teachers is the unemployment rate among those.

Equilibrium

The number of teachers needed given prevailing targets and regulations as well as the minimum wage that is required to attract enough teachers is given by the intersection of teacher demand and supply. However, binding budget constraints are often present, implying lower wages and thus lower teacher supply, which in turn means teacher shortages. These teacher shortages may be overcome through different governmental interventions as, e.g., increases into the teacher salary budget, increases in the class size, relaxed entry requirements in the profession or a combination of those. Moreover, teacher shortages may be ameliorated by employing less qualified individuals.

The interaction between the markets for certified and non-certified teachers

The simultaneous existence of both certified and non-certified teachers raise several questions: why and when do non-certified teachers get employed, what is the explanation behind the fact that non-certified teachers are employed at the same time as there exist unemployment among certified teachers and how is the demand for teachers divided between certified and non-certified teachers?

[22] The number of teaching positions (full time positions) in the Swedish public compulsory school has constantly increased from slightly more than 74,000 in 1995/96 to slightly below 84,000 in 2003/2004. Source: www.skolverket.se.

These are complex tasks and most of them go beyond the scope of this paper. However, using a simple diagrammatic approach we try to emphasize the relevant mechanism for our study: given an increase in the total demand for teachers, changes in the teaching staff composition may depend on the supply of certified teachers, i.e., the employment of non-certified teachers can be interpreted as a solution to teacher shortage among certified teachers, at least in the short run.

Given the separate demand and supply curves for certified and non-certified teachers shown in Figure 1, the total teacher demand and supply, as well as the division between certified and non-certified teachers are shown in Figure 2. D_C is the demand for certified teachers, D_N is the demand for non-certified teachers, S_{TOT} is the total teacher supply, D_{0TOT} is the initial total teacher demand, and T_{0C}, T_{0N} and T_{0TOT} represent the initial levels of certified, non-certified and total number of teachers. The initial total teacher demand curve in Figure 2 and 3 is obtained by horizontal summation of the demand curves for certified and non-certified teachers, while the demand shock is emphasized by a parallel move of D_{0TOT} to D_{1TOT}.

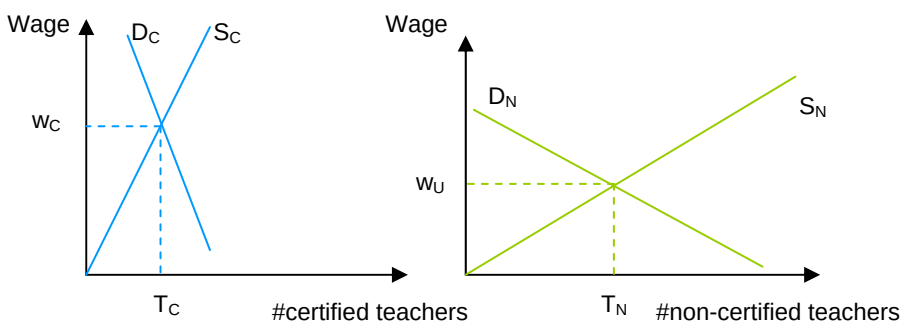

Figure 1. The markets for certified and non-certified teachers.

The initial level of a certain teacher type as well as the relative change in the number of certified and non-certified teachers due to a teacher demand shock depend on the slope of the supply curves. If the supply curve of certified teachers is steeper than the supply curve of non-certified teachers, as in Figure 1, relatively more non-certified teachers will become employed. This is shown in Figure 2 where changes in the level of certified, non-certified and total number of teachers are denoted with *1*, *2* and *3* respectively.

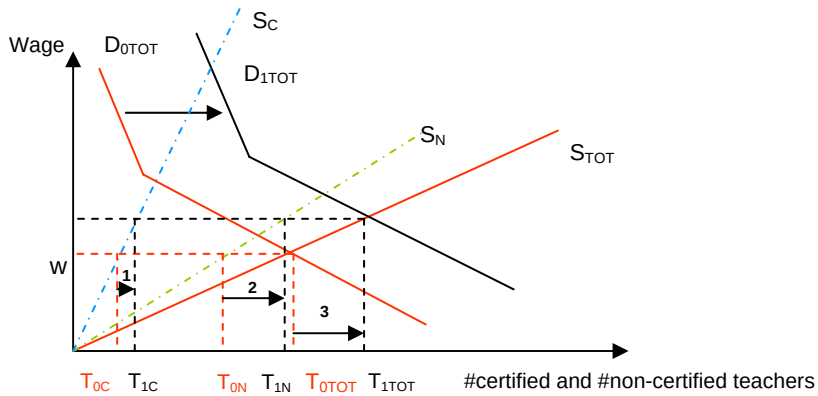

Figure 2. The market for teachers; when unemployment among certified teachers > 0.

One extreme case is when the slope of S_C is infinitely large, i.e., the supply curve for certified teachers is vertical. This case correspond to the situation when the initial level of certified teachers represents the maximum number of certified teachers that are available on the market, i.e., when the certified teacher supply restriction is completely binding. In this case and given the aim to increase the teacher density, an increase in the total demand for teachers will result exclusively in an increase in the number of non-certified teachers, since there are no more certified teachers to employ, cf. Figure 3.

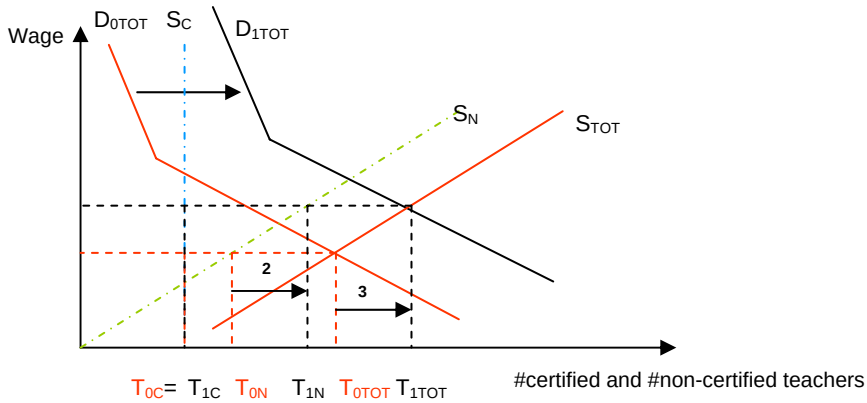

Figure 3. The market for teachers; when unemployment among certified teachers = 0.

The other extreme case is when there are no restrictions in the supply of certified teachers, i.e., when the supply curve is horizontal. In that case a teacher demand increase would lead to employment of certified teachers solely. Restrictions in the supply of certified teachers thus constitute one of the determinants of the distribution of teacher demand between certified and non-certified teachers.

However, non-certified teachers are usually present on the teacher market not only as a consequence of certified teacher shortage. In Sweden we observe that non-certified teachers are employed on teaching assignments at the same time as teachers with certification are unemployed. One possible explanation to this phenomenon is some kind of mismatch between the unemployed certified teachers and the available positions. Another explanation could be that the observed unemployment is voluntary, in the sense that potential certified applicants do not accept the offered employment conditions (wage, area, school, etc) and therefore are replaced by non-certified teachers. Finally, the presence of non-certified teachers may be explained by the fact that they, in certain situations, are preferred to certified teachers. Assuming that teachers without certification receive lower wages than their certified colleagues, the former may be preferred if the municipality's budget constraint is severe. Moreover, it would be unrealistic to assume that all certified teachers are better and more eligible than all non-certified ones. It is more reasonable to assume that the best non-certified teachers are better than the worst of the certified

ones. Thus, depending on the effectiveness of the recruiting and employing process, non-certified teachers may be preferred and employed although certified teachers are available.

3.2 The Swedish market for teachers

In this section we address some general aspects of the Swedish market for teachers and summarize the prevailing rules and institutions that govern the functioning of the market for teachers in Sweden. Regarding the school system we restrict the presentation to the structure of the compulsory school. Descriptive statistics are presented at the end of the section.

3.2.1 The structure of the market

Educational reforms

During the 1990s the Swedish educational system was gradually decentralized from the central government to municipalities and schools. Two major reforms transformed the Swedish educational system into one of the most decentralized in the world. Firstly, in 1991, the municipalities took over the responsibility for providing compulsory, upper secondary and adult education. Secondly, in 1993, grants from the central to the local authorities changed from being targeted to general, meaning that municipalities were given more autonomy in the resource allocation decisions. The central government kept the responsibility for the national objectives and general guidelines of education and curriculum. The responsibility for supporting and evaluating educational activities were divided between two institutions; the Swedish National Agency for School Improvements which supports municipalities and schools to achieve the national objectives and the National Agency for Education, which evaluates performance.[23]

The reforming of the Swedish educational system in the 1990s also implied the introduction of school choice as well as freedom to start up new schools. Independent schools could now be set up freely, although applications must be approved by the National Agency for Education after consultation with the local authorities. Introduced in 1992, the "freedom of school choice reform"

[23] The Swedish National Agency for School Improvements was established in 2003. For a more detailed description of the Agency's tasks see http://www.skolutveckling.se/in_english. The National Agency for Education is the central administrative authority for the Swedish school system. It develops syllabi and criteria for grading, reviews the quality and results of education and supervises schools and childcare providers. For a broader description see http://www.skolverket.se.

replaced the "neighborhood principle" meaning that parents can now freely choose the school they prefer instead of being allocated to a school dictated by their place of residence. Also the grading system has been reformed and in 1994 the old five-step norm-referenced grading system was replaced by a three-step criterion-referenced system related to the curriculum goals.

The new system implies that no grades are awarded for subjects before the 8th and 9th grade. Instead, schools are required to give pupils progress reports. The pupils also do standardized tests. In 9th grade these tests are mandatory in Mathematics, Swedish and English and teachers have to use the test scores when awarding final grades in these subjects.[24]

The compulsory school[25]

The Swedish compulsory school is nine years. During the six first years pupils are usually taught by one and the same teacher irrespective of subject, while during the last three they are taught by specialist teachers in each subject. Children normally start compulsory school at the age of seven although all six-years-olds are offered to participate in a one-year long pre-school class. This school-preparing class is part of the public school system but is voluntary.

Teacher certification

In Sweden a person becomes a certified teacher, i.e., receives a teacher certification, by attending and completing a teacher education program.[26] Another possibility is to receive a minor or major in the subject to be taught and supplement it with a minimum of 1.5 years of preparation in pedagogy, didactics and teaching practice. This alternative entrance to the teaching profession makes it possible for people in other professions to switch to the teaching profession and thus gives non-certified teachers a chance to become certified.

[24] Tests have been designed also for 2nd, 5th, 6th, 7th and 8th grades but these are voluntary.

[25] Compulsory school includes regular compulsory schools, schools for the Saami people of northern Sweden, special schools (for children with impaired sight, hearing or speech), and compulsory school for mentally handicapped children. However, in this paper "compulsory school" refers only to the regular compulsory schools.

[26] Teacher education programs are provided at 24 of Sweden's over 40 universities and university colleges (Ministry of Education and Science, Sweden (2003)).

Employment rules and wage bargaining

One consequence of the decentralization of the Swedish educational system in the early 1990s has been that local authorities have become the employer of most of the school staff and thus have the responsibility of recruiting them.[27] However, although the municipalities and the head of the independent schools are the formal employers of teachers, the decisions on recruiting, selecting and employing teachers are made at the school level.

Teachers may be employed on three different types of contracts: *indefinite term contracts*, *probationary period employment* and *fixed-term contracts*. Persons employed under an indefinite term contract may only be dismissed on one of the grounds mentioned in the Employment Security Act, such as for example lack of work. Probationary period employment contracts are mainly intended for newly certified teachers. These contracts normally lead to indefinite term employments. Teachers who do not have a teaching degree are often employed on a fixed-term contract (normally maximum one year).

According to the Education Act, employers must only employ teachers "whose education meets the main teacher requirements associated with the position". This usually means a Swedish teacher certification, a teacher certification from any EU or Nordic country or a corresponding education approved by the National Agency for Higher Education. However, if it is not possible to find a certified teacher, local authorities may employ persons with other educations on fixed-term contracts. Individuals without teaching degrees may be employed on indefinite term contracts only "if there are no applicants with a teaching degree, special reasons exist and the applicant has equivalent qualifications for the teaching associated with the post and appears to be suited for the task".

The decentralization of the school system in Sweden has also lead to the introduction of individually negotiated components in teacher contracts, meaning for example that the previous fixed pay scheme with pay ladders has been abolished.[28] The pay agreements that still exist only specify a minimum wage level after one year's employment, while the actual levels are determined by the school management.

[27] Except the local authorities, also the independent schools are school personnel employers.
[28] Ministry of Education and Science, Sweden (2003).

3.2.2 Descriptive statistics

Statistics from the Swedish National Agency for Education show that the teacher density in public compulsory schools, measured as full time equivalent teachers per 100 students, decreased from 7.9 in 1995 to 7.6 in 2000. This development was however interrupted in 2001 when the teacher density started to increase, reaching a level of 8.1 teachers per 100 students in 2004. The number of teachers increased by around 10,000 individuals between 1996 and 2003 but the data does not reveal the exact distribution of this increase between certified and non-certified teachers. The distribution of the share of non-certified teachers in public compulsory Swedish schools at the municipality level between 1995/96 and 2003/04 can be seen in Figure 4.[29]

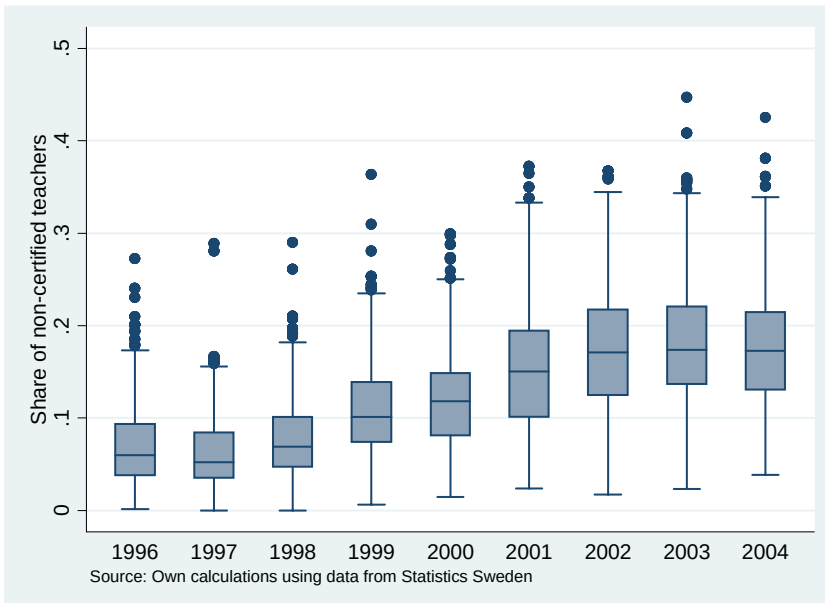

Figure 4. Distribution of the share of non-certified teachers, all Swedish municipalities.

As Figure 4 shows, the median share of non-certified teachers in public school increased during most of the years included in the study. We can, however, see a slowdown of this development towards the end of the period. More precisely,

[29] We use 1996 for the academic year 1995/96 and so on for the rest of the years. The same notation will be used in all figures.

the median share of non-certified teachers in compulsory schools increased from 6.8 percent in 1995/96 to 17.8 percent in 2002/03 and remained relatively constant at this level during the last year of study. We notice also that the dispersion between municipalities has increased over the years.[30] Figure 5 shows the relative development of the mean shares of different types of teachers at the national level.

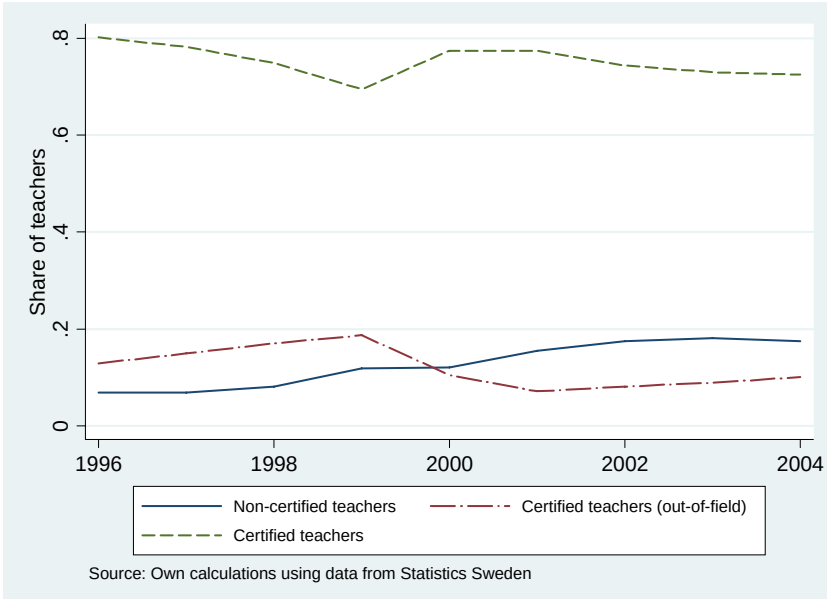

Figure 5. Mean shares of different types of teachers.

The mean share of certified teachers matching their teaching appointment declined from about 80 percent in 1995/96 to just above 70 percent in 2003/04 with a trend break in 1998/1999. The share of *out-of-field* teachers increased in the first three years of the period reaching almost 19 percent in 1998/99 when the trend was broken and it started to decline. During the last three years of our period of study the share of *out-of-field* teachers stayed at a relatively steady level of around 10 percent.

[30] This is however partly explained by the fact that the variance is given by (share of non-certified teachers) · (1-share of non-certified teachers) and as long as the share of non-certified teachers is less than 50 percent the variance is increasing in this share.

In addition to certification, teacher quality depends on teaching experience. In our analysis experience is measured as the number of active years teaching and the data show that the mean number of active years in the teaching profession decreased from about 15.7 years in 1999/2000 (the first year this information is available) to about 14.9 years in 2002/03. During the following year the development was reversed and the mean number of active years in teaching increased to 15.1.

Complementary to active years in teaching, the mean age of teachers can also be viewed as an approximation for teacher experience. The teachers' mean age (at the municipality level) follows a similar pattern as the number of active years of teaching, i.e., a decrease during 1995/96 - 2002/03 (from 46 to 45 years) with a recovery during 2003/04. According to Björklund et al (2005) the median age of certified teachers in Sweden has increased from 32 years-of-age in 1975 to 46 years-of-age in 2000.

The unemployment rate among certified teachers that reported searching for teaching appointments decreased between 1996/97 and 2002/2003 from around 3.5 percent to just below 2 percent. The rate then increased slightly and reached a level of nearly 3 percent in 2003/04. The development of the unemployment rate among *all* certified teachers shows a similar pattern but the levels are roughly 1.5 percentage points higher.[31] This difference may be explained by the fact that some certified teachers have left the teaching profession because of, e.g., low relative wages and increased stress. The monetary incentives to become a teacher have deteriorated during the last decades (Björklund et al (2005)). Relative to production workers' wages, teacher wages have declined precipitously since the beginning of the 1940s. Since 1945 the decline in the relative wage amounts to almost 50 percent. The same phenomena have been seen in a number of countries but the decline in Sweden has been particularly steep. Teachers in Sweden today are paid less than their Nordic and OECD counterparts (OECD (2002)).

To our knowledge there are no studies of earnings differences between certified and non-certified teachers in Sweden. To closer examine this fact we estimate Mincer type ordinary least squares (OLS) regressions, using annual earnings data for all employed compulsory level teachers in Sweden. Since we only have information on annual earnings we restrict our sample to teachers employed full time. When yearly earnings are regressed against a single dummy variable for certification it can be concluded that expected yearly

[31] Figure A1 in Appendix shows the development of the two teacher unemployment rates.

earnings are between 25 and 35 percent higher for certified teachers.[32] The result is statistically significant, but probably somewhat exaggerated since the full-time measurement is done at a single point in time.[33] Much of these differences in earnings can be attributed to differences in individual characteristics between certified and non-certified teachers. We know from our data that non-certified teachers are on average younger, have less experience and are less educated than their certified colleagues. To control for such individual specific characteristics we include age, age squared, number of active years teaching, number of active years teaching squared, dummy variables for educational attainment and a dummy variable for gender. To be able to distinguish possible differences in earnings between certified and non-certified teachers we also include a dummy variable for certification. The dependent variable is the logarithm of earnings and the results from these regressions can be seen in Table 1.

[32] Estimates of the dummy variable multiplied by 100 are not directly interpretable as the percentage of that variable on the earnings variable, see for example Halvorsen & Palmquist (1980).
[33] Regression results can be found in Appendix, Table A2.

Table 1. Differences in annual earnings between certified and non-certified teachers. OLS regressions including individual characteristics as control variables.

	(1)	(2)	(3)	(4)
Year	2000	2001	2002	2003
Dummy if	0.0540***	0.0615***	0.0466***	0.0217***
certified	(0.0087)	(0.0076)	(0.0066)	(0.0058)
Age	0.0528***	0.0422***	0.0398***	0.0387***
	(0.0020)	(0.0019)	(0.0018)	(0.0017)
Age^2	-0.0006***	-0.0005***	-0.0004***	-0.0004***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Active years	0.0130***	0.0118***	0.0130***	0.0119***
teaching	(0.0009)	(0.0009)	(0.0008)	(0.0007)
Active years	-0.0001***	-0.0001**	-0.0001***	-0.0001***
$teaching^2$	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Male	0.0692***	0.0748***	0.0733***	0.0724***
	(0.0036)	(0.0032)	(0.0032)	(0.0029)
Upper	0.0081	0.0185	-0.0234	0.0151
secondary	(0.0432)	(0.0370)	(0.0286)	(0.0273)
Some	0.0259	0.0362	0.0233	0.0472**
university	(0.0448)	(0.0386)	(0.0293)	(0.0289)
University	0.1561***	0.1424***	0.1333***	0.1811***
	(0.0421)	(0.0362)	(0.0270)	(0.0260)
Constant	10.8813***	11.1431***	11.2077***	11.2076***
	(0.0591)	(0.0513)	(0.0432)	(0.0416)
Observations	51,880	52,844	55,287	55,218
R^2	0.16	0.18	0.17	0.18

Note: Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. The reference group for educational level is compulsory schooling. *Some university* indicates a maximum of two years of university studies and *university* indicates more than two years of university studies.

After controlling for individual characteristics we can conclude that estimated annual earnings for certified teachers are between two and six percent higher than for non-certified teachers. This difference is highly statistical significant. Earnings are also higher for older, more experienced and more educated teachers as well as for male teachers compared to females. We can also observe a weak downward trend in the earnings difference for the years we study.

From this exercise it is possible to conclude that differences in earnings between certified and non-certified teachers do exist, but they do not seem to be very large when controlling for individual characteristics. This fact would indicate that the employment of non-certified teachers can not be explained only by the fact that they are cheaper to employ. We also observe a downward trend in the earnings differences between the two groups. Expected mean

annual earnings for certified teachers are between SEK 238,400 and SEK 255,300. The corresponding expected mean annual earnings for non-certified teachers vary between SEK 176,800 and SEK 203,600.

3.3 Previous literature on teacher certification

Studies of efficiency differences between certified and non-certified teachers are scarce. However, some examples are Hawk, Coble & Swanson (1985), Fuller (1999), Felter (1999), Darling-Hammond (1999a, 1999b) and Goldhaber & Brewer (2000). All of them provide evidence in favor of certified teachers. Also the literature dealing with the impact of teachers' initial education in terms of subject-matter knowledge and pedagogical preparation is quite limited. The evidence is mixed and studies like Monk & King (1994) find positive as well as negative, usually insignificant, effects of teachers' subject-matter education on students' results.[34] Although conducted at a high level of aggregation and thus without accounting for differences across grade levels and subject areas, existing studies have found a relatively strong and consistently positive effect of pedagogical course work on teacher effectiveness; see for example Ashton & Crocker (1987) and Evertson, Hawley & Zlotkin (1985). However, holding a master's degree in education has been shown not to improve teachers' skills and effectiveness; see Hanushek (1986) and Rivkin, Hanushek & Kain (2005). Hanushek (1997, 2002, 2003) present a literature survey showing that only 9 percent of all estimates of teacher education on student achievement are positive and at the same time statistically significant, while the corresponding percentages for teacher experience, teacher-pupil ratio and expenditure per pupil are 29, 14 and 27 respectively. Given the contradictory results offered by previous studies it is hard to conclude that there exist any strong link between teacher certification and teacher education, on the one hand, and teacher effectiveness, on the other hand.

The literature on the determinants of teacher supply is broader but not less contradictory. The OECD report "Teacher demand and supply: Improving teaching quality and addressing teacher shortages" (2002) discusses some plausible determinants of teacher supply and reviews some of the relevant literature. Issues such as relative salaries, working conditions, status of the profession, teacher training and certification and relative availability of positions may affect not only the supply of qualified teachers, and therefore the

[34] For a broader literature review see Santiago (2004).

composition of the teaching staff over time, but also the distribution of these teachers between schools and districts.

Theoretically, large differences in relative wages between teaching and non-teaching occupations affect the teacher supply and quality. The lower the teacher salaries are compared to other professions, the lower is the chance of attracting (top) students to become teachers, and the lower is the chance of keeping teachers within the teaching profession, ceteris paribus. The empirical evidence on this question is however somewhat ambiguous. Dolton (1990) for example, presents evidence confirming this theory. He found that a graduate is less likely to choose a teacher career the lower the relative wages or wage growth in teaching are. On the contrary, Hanushek & Pace (1994, 1995) find that relative earnings of teachers compared to other collage graduated do not have a large or statistically significant impact on students' choice. Regarding the effect of relative wages on teachers' probability of exiting the profession Murnane & Olson (1989, 1990) and Dolton & van der Klaauw (1999) find that higher teacher pay reduces the probability that teachers leave the profession.

Large salary gaps among different teachers may cause teacher deficits and teacher quality imbalances between schools and districts. The argument is that the best (most qualified) teachers prefer to work in schools and districts that offer the highest salaries, everything else constant. However, Hanushek, Kain & Rivkin (2004) find little or no evidence that higher salaries attract quality teachers. Their results show that school districts offering higher salaries and better working conditions do not attract the higher quality teachers among those who leave the central city district.

To investigate the importance of working conditions, Mont & Rees (1996) simulate the effects of changing classroom characteristics on high school teacher turnover and find that class load characteristics are important correlates to job turnover. They argue that efforts to reduce educational expenditures by increasing class size and by asking teachers to teach outside their areas of certification may be undermined by increased teacher turnover.

Flyer & Rosen (1997) provide evidence that the teaching profession is more flexible in terms of leaves compared to other sectors, which have shown to be an important attraction to women. Compared to other collage graduates who lose roughly nine percent for each year spent out of the labor market, teachers do not suffer such wage penalties. Since women are predominating in the teaching profession, it is reasonable to assume that the gender desegregation of the labor market since the 1960s has affected the supply and quality of

teachers. At the same pace as women begun educating themselves to a greater extent and entering the labor market, the professional diversity they were offered increased, leading to a decline in their relative interest for the teacher profession. Schools have nowadays to compete with other sectors for the educated women. The teacher selection problem has been highlighted in Temin (2002), and Corcoran, Evans & Schwab (2004) who show results supporting the theory of increased labor market opportunities for high ability women as an underlying cause to the decline in the supply of highly skilled teachers.

Lakdawalla (2006) argues that the decline in the relative wages and in the teacher quality is a result of skill-biased technological change. The productivity of skilled non-teachers has risen since their knowledge has grown and improved as a result of innovation. The productivity of skilled teachers has however remained constant because the general knowledge used by teachers (reading, arithmetic, etc) has remained largely unchanged. Since the price of teacher skill has risen relative to the price of teacher quantity, schools responded by replacing quality with quantity, i.e., by hiring non-certified teachers and raising the quantity of teachers employed.

4 Model

4.1 Motivation and hypotheses

The composition of the teaching staff within a municipality or school is obviously influenced by many factors. Budget constraints, the availability of different types of teachers, the relative wages of these and municipality and school specific aspects are examples of such factors. Differences in municipalities' economic and social situation, as well as other municipality and school specific factors such as political governance and geographical location may partly explain the increased dispersion in teacher staff composition between municipalities that we observe in Sweden. General economic distress and concomitant social problems within a municipality may scare away certified teachers who usually have other labor market options. A small budget allocated to teacher employment in combination with relatively cheap non-certified teachers may lead to an intensified use of non-certified teachers.

However, given the Swedish school law which, in principle, claims that non-certified teachers may be employed only unless certified teachers are not available, we argue that the observed increase in the share of non-certified teachers could be explained by restrictions in the supply of certified teachers.

When certified teachers are not available an alternative to having a teacher deficit is to employ non-certified teachers. We therefore expect a municipality characterized by an increasing supply of certified teachers to show a decline in the share of non-certified teachers in schools. Differences in the share of non-certified teachers between municipalities may thus be partly explained by the fact that they meet different supply restrictions on certified teachers.

In the present paper we concentrate on this teacher "supply effect", i.e., on how supply restrictions among certified teachers affect the teacher employment decisions and therefore the composition of the teaching staff. By making use of the Wärnersson grant (*WG*) we are able to diminish the budget effect and isolate the supply effect. Since the *WG* is a targeted grant it may only be used for employment of school personnel, meaning that municipalities cannot allocate the grant for other purposes. The budget constraint for teacher employment is thus reduced in the sense that it plays a minor role in the employment decisions. Moreover, the way in which the grant amount for each municipality is determined implies that no municipality specific factors or shocks affect it. Thus, by studying the effects of the introduction of the *WG* on the share of non-certified teachers and by specifically studying how the introduction of the *WG* changes this share in areas with different levels of teacher unemployment, we are able to isolate a "supply effect".

We expect the introduction of the grant to lead to a relatively larger decrease in the share of non-certified teacher in municipalities characterized by a large supply of certified teachers, i.e., a high unemployment rate among these teachers, than in municipalities with a low supply of certified teachers. The intuition is that when receiving the grant municipalities facing supply restrictions among certified teachers are forced to increase the teacher density by employing non-certified teachers, thus leading to an increase in the share of non-certified teachers relative to municipalities that have the possibility of employing certified teachers.

Even though the budget effect is neutralized by the design of the *WG* there may still be a "strategic effect" which depends on a municipality's economic situation. Being aware of the difficulties a low budget involves, school leaders within poor municipalities may try to employ predominantly certified teachers during the grant period, in that way profiting from the temporary extra resources in order to increase school quality and reputation, especially since schools probably benefit from the improved reputation also after the grant period is terminated. This effect is probably relatively small and although it can

be difficult to observe and measure we can still account for it by controlling for school specific factors.

To summarize, the focus of the paper is on whether the increasing share of non-certified teachers can be explained by a shortage in the stock of certified teachers. The *WG* gives us an opportunity to isolate the effect of supply restrictions on the composition of the teaching staff.

4.2 Econometric framework

The hypothesis that restrictions in the teacher supply affect the composition of teaching staff can be tested in different ways. This could be estimated using a fixed effect model that controls for school fixed effects, but another option is a difference-in-difference approach that makes use of the introduction of the *WG* in order to identify the effect of interest. We describe and estimate both of these approaches. The basic model is:

$$Y_{it} = \beta_0 + \beta_1 TeachUnempl_{jt} + \varepsilon_{ijt} \qquad (1)$$

where Y_{it} denotes the share of non-certified teachers in school i in period t, $TeachUnempl_{jt}$ is the unemployment rate among certified teachers in local labor market (LLM) j in period t and ε_{ijt} is the idiosyncratic error term. The parameter of interest is β_1 which is expected to be negative. However, it is not reasonable to believe that the estimate of β_1 will be consistent when the model is estimated by OLS on register data. There are two major potential problems; reversed causality and omitted variables bias, both implying endogeneity in the model. Reverse causality is in effect since the number of certified teachers is included in the denominator of Y_{it}. If, for example, a lot of certified teachers are fired, then the share of non-certified teachers will increase and the unemployment rate among the certified ones will increase as well. Further, the heterogeneity between schools implies that there may exist school specific factors or within school shocks which, if omitted, lead to a bias in the OLS estimator.

One solution to the omitted variable problem is to use a fixed effects estimation model, allowing for school specific factors that are constant over time and thereby mitigate the endogeneity problem. The fixed effects model to be estimated is therefore:

$$Y_{it} = \beta_0 + \beta_1 TeachUnempl_{jt} + \gamma X_{kjt} + a_i + \delta_t + \varepsilon_{ikjt} \qquad (2)$$

where X, a_i and δ_t represent a vector of control variables, the school specific effects and a time trend respectively. The X-vector may contain, e.g., the overall unemployment rate in the LLM and the municipality income equalization grant. The former may be seen as a proxy for the general economic situation, while the latter may be argued to be a proxy for a municipality's budget constraints and possibly also its social situation.

Given that the strict exogeneity assumption holds, i.e., that the idiosyncratic error is not correlated with the explanatory variables across all time periods, the fixed effects estimator will be a consistent estimator of β_1. However, the strict exogeneity assumption is a strong assumption and it is hard to argue that it actually holds. Moreover, the fixed effects model may solve the omitted variable problem but not the endogeneity caused by the reverse causality.

An alternative approach is to exploit the *WG* and analyze the situation using a difference-in-difference approach. By doing so, we do not have to assume strict exogeneity in the school-specific fixed effects.

In simple terms, we can divide the municipalities into two groups: the ones that face low or no teacher supply restrictions, i.e., where there are many unemployed certified teachers and the ones where the unemployment rate is low or even zero.[35] The former define our "control group" while the latter constitute the "treatment group". The "treatment" is the introduction of the *WG* in 2001/02 which divides the data into six years of "non-treatment" and three years of "treatment". We expect the composition of the teacher staff to be more affected by the *WG* in municipalities where the supply restrictions are large than in municipalities where these restrictions are low or absent. In other words, we expect the introduction of the *WG* to lead to a larger decrease in the share of non-certified teachers in municipalities characterized by high unemployment among certified teachers than in municipalities characterized by low teacher unemployment. This would imply that restrictions on the supply of certified teachers do matter for the teacher staff composition.

The model is in this case given by:

$$\begin{aligned} Y_{it} &= \beta_0 + \beta_1 TeachUnempl_{jt} + \beta_2 WG_{kt} + \\ &\beta_3 WG_{kt} \cdot TeachUnempl_{jt} + \gamma X_{kjt} + \delta_t + \varepsilon_{ikjt} \end{aligned} \tag{3}$$

[35] The minimum unemployment rate among certified teachers at the LLM level is 0 percent and the maximum is 8.56 percent.

where WG_{kt} is the grant in municipality k at time t and X_{kjt} represents a vector of control variables in the same manner as in the fixed effects model. The variable of interest here is the interaction term $WG_{kt} \cdot TeachUnempl_{jt}$. The parameter β_3 measures the average marginal impact of the *WG* on the average share of non-certified teachers in municipalities with different levels of teacher unemployment and we expect it to be negative. Under the assumption of additive separability between $TeachUnempl_{jt}$ and WG_{kt} we may interpret the OLS estimate of β_3 as causal. Further, the parameter β_2 is here interpreted as the average grant effect in municipalities where the unemployment rate among certified teachers is zero. This interpretation is possible under the assumption that the *WG* is distributed exogenously among municipalities. Such an assumption is reasonable since the only factor affecting the grant amount is the school-aged population in a municipality, which can not be influenced in the short run.

In the difference-in-difference approach we do not include any school specific effects. The reason is our focus on the interaction term. Since the WG_{kt} is considered to be determined in an exogenous manner the only factor that may cause problems is $TeachUnempl_{jt}$ but by separately controlling for it in the model, we take care of these potential problems and argue that the estimate of β_3 has a causal interpretation.[36] The $TeachUnempl_{jt}$ variable is thus used as a control variable without causal interpretation.

Thus, by making use of the introduction of the *WG* and conditioning on the unemployment rate among certified teachers, while everything else is kept constant, we are able to isolate the marginal effect of supply restrictions.

[36] The error term can be argued to contain factors that are correlated with $TeachUnempl_{jt}$ as well as with the dependent variable Y_{it}.

5 Results

The two model specifications discussed in the previous section are implemented as follows: the dependent variable is measured at the lowest aggregation level, i.e., the school level, the teacher unemployment rate refers to the unemployment rate among certified teachers that are reporting to be searching for teaching appointments, and the estimates are weighted by the number of students per school.[37]

We begin the analysis by estimating the school fixed effect model which assigns a dummy variable to each school; in this way allowing for school specific factors in the model. By doing so we avoid some of the endogeneity problem caused by potential correlation between the error term, ε_{ikjt}, and the explanatory variable $TeachUnempl_{jt}$.

The results are presented in Table 2. In specification (1) we only include our variable of interest, the unemployment rate among certified teachers. The estimate, which is highly statistically significant, shows that an increase in the unemployment rate among certified teachers with one percentage point implies a decrease of 0.41 percentage points in the share of non-certified teachers. The mean unemployment among certified teachers is about 2.7 percent over the entire studied time period while the mean share of non-certified teachers is around 10.4 percent. The results indicate that a doubling of the mean unemployment rate, i.e., an increase with 2.7 percentage points, would lead to a decrease of 1.1 percentage points in the average share of non-certified teachers, which corresponds to a 10.7 percent decrease in the share of non-certified teachers. The result supports our hypothesis that increases in the supply of certified teachers lead to decreases in the share of non-certified teachers in schools.

Stepwise, we include the overall unemployment rate at the LLM level as well as the municipality income equalization grant. As shown in column (2) and (3)

[37] In additional regressions, not presented here, the model specifications have also been estimated by aggregating the dependent variable at the municipality level. Moreover, we have also used the broader definition of the teacher unemployment rate and a different measure of certification but none of these variations have showed to change our qualitative results. Furthermore the same models have both been estimated without weighting the estimates with the number of students per school and by weighting them with the number of teachers per school. These variations do not change the results either. Tables of these estimations can be made available by the authors on request.

in Table 2 the teacher unemployment estimate is quite robust and the magnitude of the estimate does not change significantly.

Table 2. OLS estimates with school fixed effects and the share of non-certified teachers as dependent variable.

	(1)	(2)	(3)
Teacher unemployment	-0.4115***	-0.4169***	-0.4386***
	(0.1206)	(0.1222)	(0.1313)
Overall unemployment		0.0690	0.0694
		(0.1361)	(0.1387)
Income equalization grant			0.1423
			(0.1012)
Constant	17.5596***	17.1723***	17.1802***
	(0.4476)	(0.8817)	(0.9083)
Observations	35,241	35,241	35,241
R^2	0.71	0.71	0.71

Note: Time period 1995/96 - 2003/04. Cluster corrected standard errors in parentheses (cluster = local labor market · year). Year dummies are included in the regressions.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Another interpretation of our results is the effect of teacher supply changes on the *number* of non-certified teachers with teaching appointments. Differentiation of Equation (2) leads after some algebra to the following result:

$$\frac{dn_n}{du_c} = \beta_1 \left(\frac{n_n + n_c}{n_c + u_c} \right)^2 \qquad (4)$$

where n_n is the number of employed non-certified teachers, n_c is the number of employed certified teachers and u_c is the number of unemployed certified teachers. Assuming that $u_c = 3$, $n_n = 97$ and $n_n = 12$ and using the β_1 estimate from specification (1) in Table 2 we get that $\frac{dn_n}{du_c} = -0.49$.[38] Thus, an increase in the unemployment of certified teachers with 100 individuals will result in a decrease on average in the number of non-certified teachers by 49 individuals. This can be considered to be a relatively large effect, indicating that restrictions in the supply of certified teachers seem to be rather important when trying to explain the employment of non-certified teachers.

[38] With these assumed numbers we achieve an unemployment rate among certified teachers and a share of non-certified teachers that is approximately equal to the mean in our sample.

However, as discussed in the former section, one drawback with the fixed effects model is the potential inconsistency of the estimate of β_1 caused by the potential reverse causality between teacher unemployment and the share of non-certified teachers. Another drawback is the assumption of strict exogeneity in teacher unemployment. An alternative approach that does not require the strict exogeneity and that is not affected by the potential reversed causality between the unemployment rate and the share of non-certified teachers is to make use of the *WG*.

We estimate the model described by Equation (3) in section 4.2 by an OLS model and the results are presented in Table 3. The parameter of interest is the one associated with the interaction term between the *WG* and the teacher unemployment rate. This parameter represents the marginal effect of teacher unemployment on the share of non-certified teachers when a demand chock for teachers occurs as a result of the introduction of the *WG*.

The estimates of the parameter of interest are negative and statistically significant. The interpretation of the result from specification (1) in Table 3 is that a one percentage point increase in the teacher unemployment rate will on the margin, given the *WG*, decrease the share of non-certified teachers with 0.57 percentage points on average.

As a sensitivity analysis we add more controls variables to specification (1), cf. specifications (2) and (3). The overall unemployment rate at the LLM level and the municipality income equalization grant are included stepwise and we note that the original results are relatively robust. Depending on model specification, a one percentage point increase in the teacher unemployment, due to the introduction of the *WG*, decreases the share of non-certified teachers by 0.57 to 0.61 percentage points, ceteris paribus. We can thus conclude that our initial hypothesis that supply restrictions among certified teachers affect the teaching staff composition is once again supported by our findings.

Similarly to equation (4), we can calculate the effect of teacher supply changes on the *number* of non-certified teachers with teaching appointments. Differentiation of equation (3) yields:

$$\frac{dn_n}{du_c} = \beta_3 \cdot WG\left(\frac{n_n + n_c}{n_c + u_c}\right) \tag{5}$$

Evaluated at the mean level of the *WG*, using the estimate of β_3 from specification (1), and given the same assumed numbers as before an increase in

the unemployment of certified teachers with 100 individuals will on average result in a decrease in the number of non-certified teachers with 81 individuals. Given the mean level of the *WG*, restrictions in the supply of certified teachers are very important in explaining the employment of non-certified teachers.

An interesting finding is the total effect of the *WG* on the share of non-certified teachers. The estimate of the *WG* coefficient (β_2) is positive and statistically significant in all specifications, indicating that the introduction of the *WG* has a positive direct effect on the share of non-certified teachers in schools. As we have argued earlier in the paper the *WG* is determined in an exogenously way, which allow us to interpret β_2 as a causal effect. The total effect of the *WG* on the percentage of non-certified teachers is given by;

$$\frac{dY_{it}}{dWG_{kt}} = \beta_2 + \beta_3 TeachUnempl_{jt} \qquad (6)$$

meaning that according to specifications (1) - (3) the total effect of an increase in the grant level with one unit (SEK 1,000), keeping the unemployment rate at its mean (= 2.57), will increase the percentage of non-certified teachers with between 6.4 and 7.1 percentage points which is a large effect indeed. A one unit increase in the *WG* would leave the composition of the teachers unchanged if the unemployment rate among teachers would be between 13 and 14 percent.

From these estimates we can infer that restrictions in the supply of certified teachers are very important in explaining the teacher composition when a teacher demand shock like the *WG* occurs.

Table 3. OLS estimates with the share of non-certified teachers as the dependent variable.

	(1)	(2)	(3)
WG · Teacher unemployment	-0.5682**	-0.6235***	-0.6090***
	(0.2210)	(0.2205)	(0.2021)
WG	7.8832***	8.1199***	8.6833***
	(1.8863)	(1.8479)	(1.7212)
Teacher unemployment	-0.5839***	-0.4889***	-0.6287***
	(0.1791)	(0.1796)	(0.1560)
Overall unemployment		-0.8771***	-0.7114**
		(0.3238)	(0.2799)
Income equalization grant			-0.2170***
			(0.0366)
Constant	7.3188*	12.0396***	10.5024**
	(4.0713)	(4.6477)	(4.1621)
Observations	35,241	35,241	35,241
R^2	0.18	0.19	0.19

Note: Time period 1995/96−2003/04. Cluster corrected standard errors in parentheses (cluster = local labor market · year). Year dummies are included in the regressions.
* significant at 10%; ** significant at 5%; *** significant at 1%.

To summarize, our results provide evidence that restrictions in the supply of certified teachers are important in explaining changes in the teacher composition when a teacher demand shock occurs, like the one caused by the introduction of the *WG*. On the margin, the *WG* leads to decreases in the share of non-certified teachers in schools, relatively more in LLM that meet low teacher supply restrictions than LLM that meet high teacher supply restrictions. Moreover, our results show a side effect of the *WG*; except the increased teacher density, which was the aim of the grant, it has also increased the share of non-certified teachers in schools.

6 Conclusions

We have shown that supply restrictions among certified teachers do have an impact on the teacher composition in Swedish compulsory schools. Using a special targeted government grant, the Wärnersson grant, as an instrument we have been able to isolate the marginal effect of (certified) teacher supply on the share of non-certified teachers. The effect has been shown to be negative and

substantial. The fact that non-certified teachers get employed at the same time as there exist unemployment among certified teachers indicates, however, that except teacher shortages there may also be other explanations to the employment of non-certified teachers. Non-certified teachers may be demanded alongside their certified colleagues for other reasons than teacher shortages. Moreover, there may exist some kind of mismatch between teaching vacancies and eligible applicants.

The aim of the Wärnersson grant has been to employ more teachers and school personnel, i.e., to increase the school personnel density. This goal seems to have been attained but our analysis reveals an interesting short run effect of the introduction of this grant. It has implied an increase in the share of non-certified teachers. The extra contribution to the school budget in combination with a supply deficit among certified teachers has lead to an increase in the share of non-certified teachers. Schools in LLMs with low unemployment among certified teachers were probably forced to employ non-certified teachers to fulfill the requirements of the grant. Thus, the demand shock that the *WG* implied together with the restrictions in the supply of certified teachers can partly explain the increase in the share of non-certified teachers that has occurred in compulsory Swedish schools between 2000/01 and 2003/04. Moreover, since the supply of certified teachers differ between municipalities and LLMs, the *WG* may have contributed to increased differences in the composition of the teaching staff between municipalities.

The fact that the introduction of the *WG* has lead to an increase in the share of non-certified teachers is an important result for policy implications. If non-certified teachers are considered less desirable than certified teachers, such a targeted grant should be combined with an effort to increase the supply of certified teachers. The government can affect the supply of such teachers by, e.g., taking measures to increase the status of the teacher occupation, in that way attracting more individuals into the profession and also inducing certified teachers that have left teaching to re-enter the teaching profession.

Whether non-certified teachers can be considered eligible or not is an interesting question and the answer depends on their effect on the school quality and thus on student achievement. In future work we aim to study whether the composition of the teaching staff, i.e., the share of non-certified teachers, has an affect on student achievement.

References

Ahlin Å & E Mörk (2007) "Effects of decentralization on school resources: Sweden 1989-2002", Forthcoming *Economics of Education Review*.

Ashton P & L Crocker (1987) "Systematic study of planned variations: the essential focus of teacher education reform", *Journal of Teacher Education*, 38(3), May-June, pp. 2-8.

Bacolod M P (2002) "Do alternative opportunities matter? The role of female labor markets in the decline of teacher supply and teacher quality, 1940-1990" Economics Working Papers No. 02-03-02, University of California Irvine.

Björklund A, M Clark, P-A Edin, P Fredriksson & A Kreuger (2005) "The market comes to education in Sweden: an evaluation of Sweden's surprising school reforms", Russell Sage Foundation.

Corcoran S, W N Evans & R M Schwab (2004) "Changing Labor-Market Opportunities for Women and the Quality of Teachers 1957-2000", *American Economic Review*, 94(2), pp. 230-235.

Darling-Hammond L (1999a) "Teacher quality and student achievement: a review of state policy evidence", *research report, Center for Study of Teaching and Policy*, University of Washington.

Darling-Hammond L (1999b) "State teaching policies and student achievement", *Teaching Quality Policy Brief, Center for the study of Teaching and Policy*, University of Washington.

Dolton P J (1990) "The Economics of UK Teacher Supply: The Graduate's Decision", *The Economic Journal*, 100(400), pp. 91-104.

Dolton P J & W van der Klaauw (1999) "The Turnover of Teachers: A Competing Risk Explanation", *The Review of Economics and Statistics,* 81(3), pp. 543-552.

Evertson C, W Hawley & M Zlotnik (1985) "Making a difference in educational quality through teacher education", *Journal of Teacher Education*, 36(3), pp. 2-12.

Felter M (1999) “High school staff characteristics and mathematics tests results”, *Education Policy Analysis Archives*, 7(9).

Flyer F & S Rosen (1997) “The new Economics of Teachers and Education”, *Journal of Labor Economics*, 15(1), pp. 104-139.

Fuller E J (1999) “Does Teacher Certification Matter? A Comparison of TAAS Performance in 1997 Between Schools with Low and High Percentages of Certified teachers”, University of Texas at Austin, Charles A. Dana Center, Austin Texas.

Goldhaber D D & D J Brewer (2000) “ Does teacher certification matter? High school teacher certification status and student achievement”, *Educational Evaluation and Policy Analysis*, 22(2), pp. 129-45.

Halvorsen R. & R. Palmquist (1980) “The Interpretation of Dummy Variables in Semilogarithmic Equations”, *American Economic Review*, 70(3), pp 474-475.

Hanushek E (1986) “The economics of schooling: production and efficiency in public schools”, *Journal of Economic Literature*, 24(3), pp.1141-77.

Hanushek E (1997) “Assessing the Effects of School Resources on Student Performance: An Update”, *Educational Evaluation and Policy Analysis,* 19(2), pp. 141-164.

Hanushek E (2002) “Publicly provided education”, in A.J. Auerbach and M. Feldstein (eds), *Handbook of Public Economics*, vol. 4, pp. 2045-2141, Amsterdam: Elsevier Science B.V.

Hanushek E (2003) “The Failure of Input-based Schooling Policies”, *Economic Journal,* 113(485), pp. 64-98.

Hanushek E, J F Kain & S G Rivkin (2004) “Why Public Schools Lose Teachers”, *Journal of Human Resources* 39(2), pp.326-354.

Hanushek E & R Pace (1994) "Understanding Entry into the Teaching Profession" in Ehrenberg R G (ed.), *Choices and Consequences: Contemporary Policy Issues in Education*, Ithaca, NY ILR Press, pp. 12-28.

Hanushek E & R Pace (1995) "Who Chooses to Teach (and Why)?", *Economics of Education Review,* 14(2), pp. 101-117.

Hawk P P, Coble C R & Swanson (1985) "Certification: it does matter", *Journal of Teacher Education*, 36(3), pp. 13-15.

Lakdawalla D (2006) "The Economics of Teacher Quality", *Journal of Law and Economics*, vol. 49(1), pp. 285-329.

Ministry of Education and Science, Sweden (2003) Country Background report prepared for the "Attracting Developing and Retaining Effective teachers' activity", Directorate for education, OECD, Paris.

Monk D H & J King (1994) "Multi-level teacher resource effects on pupil performance in secondary mathematics and science" in R.G. Ehrenberg (ed.), *Contemporary Policy Issues: Choices and Consequences in Education*, Ithaca: ILR Press, pp. 29-58.

Mont D & D Rees (1996) "The influence of Classroom Characteristics on High School Teacher Turnover", *Economic Inquiry*, 34(1), pp. 152-167.

Murnane R J & R J Olsen (1989) "The Effects of salaries and Opportunity Costs on Duration in Teaching: Evidence from Michigan", *The Review of Economics and Statistics,* 71(2), pp. 347-352.

Murnane R J & R J Olsen (1990) "The Effects of Salaries and Opportunity Costs on Duration in Teaching: Evidence from North Carolina", *Journal of Human Resources*, 25(1), pp. 106-124.

OECD (2002) "Teacher demand and supply: Improving teaching quality and addressing teacher shortages".

Riksrevisionen (2005) "Statens bidrag för att anställa mer personal i skolor och fritidshem", RiR 2005:9.

Rivkin S, E Hanushek & J Kain (2005) "Teachers, Schools, and Academic Achievement", *Econometrica*, 73(2), pp. 217-258.

Santiago P (2004) "The labour market for teachers" in International Handbook On The Economics Of Education, Ed. by Geraint Johnes And Jill Johnes, Edward Elgar Publishing, pp.

SFS 2001:36, Förordning (2001:36) om statsbidrag till personalförstärkningar i skola och fritidshem, *Svensk Författarsamling*, http://www.notisum.se/rnp/sls/lag/20010036.htm.

Stoddard, C (2003) "Why has the number of teachers per student risen while teacher quality has declined? The role of changes in the labor market for women", Journal or Urban Economics, 53(3), pp. 458-81.

Svenska Kommunförbundet (2003) *Utjämning mellan kommunerna – en kort beskrivning av dagens system*, 3:d edition.

Temin P (2002) "Teacher Quality and the Future of America", *Eastern Economic Journal*, 28(3), pp. 285-300.

Appendix

Table A1. Descriptive statistics for the complete sample.

Variable	Observations	Mean	Std. dev.
Percent non-certified teachers (school level)	35,241	10.3734	12.1629
Percent unemployed certified teachers, all teachers (local labor market level)	35,241	2.6590	1.3655
Percent unemployed certified teachers, those searching for teacher jobs (local labor market)	35,241	4.1399	1.8556
Percent overall unemployment (local labor market level)	35,241	5.1722	1.4967
Income equalization grant (municipality level), thousands of SEK/inhabitant	35,241	0.8823	2.9771
Wärnersson grant (municipality level), thousands of SEK/student	11,454	1.2044	0.5194
Teacher age (school level)	35,241	45.2572	3.9132
Active years teaching (school level)	15,329	15.2879	4.2604

Table A2. Differences in annual earnings between certified and non-certified teachers. OLS regressions without controls for individual characteristics.

	(1)	(2)	(3)	(4)
Year	2000	2001	2002	2003
Dummy if	0.2991***	0.2730***	0.2591***	0.2262***
certified	(0.0073)	(0.0062)	(0.0056)	(0.0049)
Constant	12.0827***	12.1560***	12.1791***	12.2241***
	(0.0071)	(0.0060)	(0.0054)	(0.0047)
Observations	51,880	52,844	55,287	55,218
R^2	0.05	0.06	0.06	0.05

Note: Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

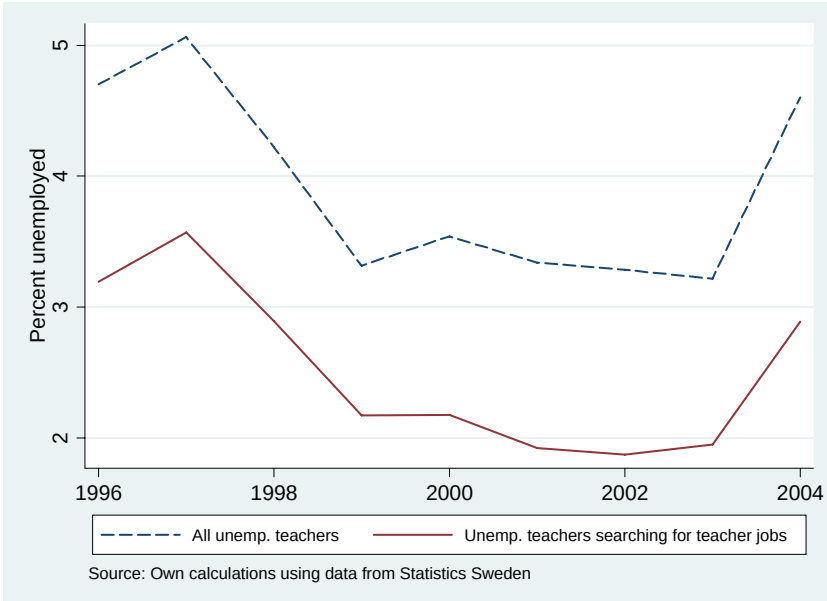

Figure A1. Teacher unemployment among certified teachers.

Publication series published by the Institute for Labour Market Policy Evaluation (IFAU) – latest issues

Rapporter/Reports

2007:1 Lundin Daniela ”Subventionerade anställningar för unga – en uppföljning av allmänt anställningsstöd för 20–24-åringar”

2007:2 Lundin Daniela, Eva Mörk & Björn Öckert **”**Maxtaxan inom barnomsorgen – påverkar den hur mycket föräldrar arbetar?”

2007:3 Bergemann Annette & Gerard van den Berg ”Effekterna av aktiv arbetsmarknadspolitik för kvinnor i Europa – en översikt”

2007:4 Junestav Malin ”Socialförsäkringssystemet och arbetsmarknaden – politiska idéer, sociala normer och institutionell förändring – en historik”

2007:5 Andersson Christian ”Lärartäthet, lärarkvalitet och arbetsmarknaden för lärare”

Working Papers

2007:1 de Luna Xavier & Per Johansson “Matching estimators for the effect of a treatment on survival times”

2007:2 Lundin Daniela, Eva Mörk & Björn Öckert “Do reduced child care prices make parents work more?”

2007:3 Bergemann Annette & Gerard van den Berg “Active labor market policy effects for women in Europe – a survey”

2007:4 Andersson Christian “Teacher density and student achievement in Swedish compulsory schools”

2007:5 Andersson Christian & Nina Waldenström “Teacher supply and the market for teachers”

2007:6 Andersson Christian & Nina Waldenström “Teacher certification and student achievement in Swedish compulsory schools”

Dissertation Series

2006:1 Hägglund Pathric “Natural and classical experiments in Swedish labour market policy”

2006:2 Savvidou Eleni “Technology, human capital and labor demand”

2006:3 Söderström Martin “Evaluating institutional changes in education and wage policy”

2006:4 Lagerström Jonas “Discrimination, sickness absence, and labor market policy”

2006:5 Johansson Kerstin “ Empirical essays on labor-force participation, matching, and trade”